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REPORT OF THE ARMY SCIENTIFIC ADVISORY PANEL AD HOC GROUP FOR LOGISTICS RESEARCH AND DEVELOPMENT

Army Scientific Advisory Panel
Washingt n, D. C.

30 September 1974

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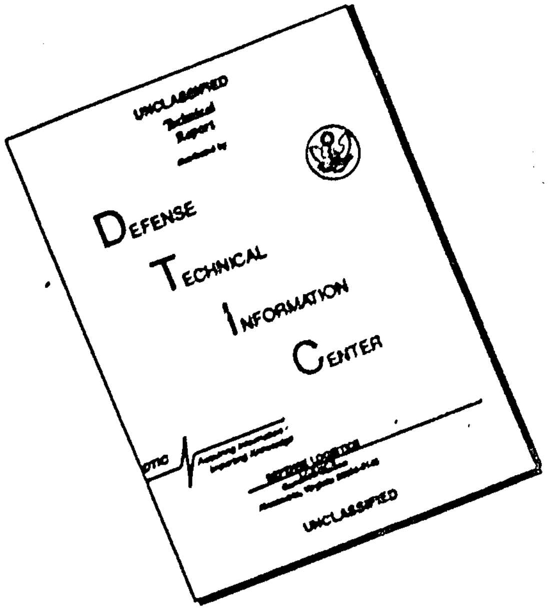

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REPORT OF

THE ARMY SCIENTIFIC ADVISORY PANEL

AD HOC GROUP

FOR

LOGISTICS R&D

JANUARY 1975

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FINAL REPORT

ARMY SCIENTIFIC ADVISORY PANEL

Ad Hoc Group on Logistics R&D

September 30, 1974

Final Report
Army Scientific Advisory Panel
Ad Hoc Group on Logistics R&D

I. Background

In the background statement of the ad hoc Group's Terms of Reference*, the observation is made that in comparison to other armies of the world, the U. S. has a very large number of support personnel compared to combat or operational personnel. It is suggested that this is due to a tremendous logistics burden that is imposed by our obligation to scatter our forces widely and to employ sophisticated equipment that demands a very high level of personnel support. Yet, as high as the ratio of U. S. support to combat forces has become, it was reported that in the analysis of the recent Arab-Israeli conflict the ratio was higher than that of the U. S.

In a climate where costs are spiraling due to inflation and where, as is usual in a peacetime economy, there is pressure brought to bear to reduce military commitments, it becomes imperative to minimize the logistics burden to the greatest extent possible. It has been suggested that this be done by trying to achieve a more favorable ratio of support to operational personnel and that R&D might play a key role in accomplishing this objective by providing for the design of more reliable, operable, and maintainable equipment, by concentrating on commonality and modular design of equipment, and by assisting in the development of more efficient transportation, distribution, communication, and maintenance equipment.

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*See Appendix A - "Terms of Reference, ASAP ad hoc Group on Logistics, R&D."

With this background, the ASAP Logistics R&D Group was asked to suggest ways in which the Army can move to a modular approach and to this end it was proposed that the desirability of capitalizing on modularity for key equipment classes be investigated, that factors impeding the implementation of modularity be identified, and that the manner in which trade-off decisions among performance, cost, and schedule be investigated.

The Group was also asked to consider the question, "What can R&D accomplish in the areas of transportation, distribution, and communications systems"? Finally, the Group was asked to make an assessment of the implications on equipment requirements of both the current deployment scenario and the predominantly CONUS based Army that would have to be rapidly deployed to nonpreposition bases.

II. Study Approach

The Group* began its deliberations by reviewing the Terms of Reference from which it was concluded that the background information was adequate to define the Army's concern and that the questions raised were suggestive of the matters to which the study group should address itself.

The Group held four two-day meetings in accordance with the schedule appearing in Appendix C. At the first meeting, the Group received overview briefings on the materiel development and acquisition cycle from the OCRDA and the overall logistic system from the ODCSLOG. On the first day of the second meeting the Group met at AMC Headquarters for briefings on the logistics support mission and ongoing projects to insure the efficiency of the AMC logistics support structure as well as briefings

*The Group membership is identified in Appendix B.

from the Marine Corps on logistics R&D. The second day of this meeting was held at Fort Belvoir where briefings were presented on MERDC activities including modular trends in equipment design and improved transportation, distribution and maintenance equipment. This meeting also afforded a visit to the Night Vision Labs to receive briefings on how NVL had exploited the modularity concept in the development of night vision devices.

The third meeting was held at Fort Lee where the Group met with the commanding officers and staff of the Army Logistics Management Center (ALMC) and the Army Logistics Center (ALOGC). Here the mission of each of these two centers was described with a run-down on the subject coverage of the course offerings given at the ALMC and logistics materiel developments at the ALOGC including container systems and the Trans-Hydro Craft Study. At the fourth and final meeting the Group met for informal discussions with the Assistant DCSLOG and the DCRDA to receive their reactions to its tentative conclusions and discuss logistics R&D problem areas.

In addition to the input that these meetings contributed to the Group's understanding of matters relating to its mission, it also had the benefit of reviewing documents relating to various aspects of the Army's logistic system. The following report is based on this input.

The scope of the study and time provided for it did not allow for an in-depth review of the Army's total logistic system. The report accordingly will not address the details of this system nor will it, indeed, respond to all of the questions directed to the Group in the Terms of Reference. Instead, it will focus on those elements of the system, in particular, relating to maintenance, supply and transportation functions that have been

identified as potentially high pay-off areas in achieving an optimized, cost-effective logistics support system.

III. Introduction

It is recognized that the Army, in its efforts to make the most effective use of limited resources in providing an effective and efficient logistic system, is constrained by policy-level legal, social and political forces. Legal constraints and congressional direction relating to the acquisition process, social considerations that require more attention to creature comforts of a modern volunteer Army, and political pressures that prevent or delay the elimination of unneeded military installations, all are beyond the Army's control.

There are other constraints that result from interactions of technological factors and/or related national policies. These include: our national decision to substitute equipment (necessarily sophisticated) for soldiers in our military force structure thus increasing more extensive logistic support, our national policy of considering and treating developing technology and its associated industrial base as a national resource, the basic fact that the achievement of maximum peacetime logistic efficiency and of maximum wartime readiness often generate directly opposing requirements, the historical tug-of-war between the configuring of general-purpose (lower life cycle cost) and special-purpose (most effective) modular system components; i.e., shelters, power trains, etc., and other policy-based requirements such as those related to environmental considerations that have cost and functional impacts in the military sector just as in the civilian sector.

The net result of these influences is that the Army, like many other corporate bodies, has the opportunity of optimizing only that part of its functional efficiency that it can control. Most of the "grease" for this wheel must come through resource management efficiency but this can be strongly bolstered by proper R&D support to capitalize rapidly on advances in technology.

The Group rejects the notion that the "teeth-to-tail" ratio should be used as a total measure of the efficiency of the logistic system. Indeed, this ratio can be misleading. On the one hand, a reduction in the ratio; i.e., fewer combat troops for a given number of support troops,can indicate that technology has been exploited beneficially to improve the combat effectiveness of the fighting man by reducing the number of combat troops needed to achieve a given military capability -- without a commensurate increase in service troops. Such a reduction in the "teeth-to-tail" ratio is certainly a desirable objective. On the other hand, if the number of support troops is disproportionately increased with respect to combat troops, without improving combat effectiveness, the system is degraded. Because of these conflicting implications of the "teeth-to-tail" ratio, as well as the difficulty in making a clear distinction between combat and support functions, it should not be used to reflect the effectiveness or the efficiency of the total system --- particularly to suggest that a low combat to support ratio is undesirable. Indeed, such a ratio can reflect how increases in logistic support to improve combat effectiveness has historically resulted in a reduction in casualty rates. This is shown dramatically in the following table.*

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*Department of Army information.

COMBAT/SUPPORT DISTRIBUTION & CASUALTY RATES
(BY MOS)

	Civil War	WWI	WWII	Korea	VN	Current
Combat	93.2%	34.1%	36.2%	33.0%	22.2%	24.0%
Support	6.8%	65.9%	63.8%	67.0%	77.8%	76.0%
Battle Casualties**	121.4	83.5	30.6	22.7	19.8	
Battle Deaths**	42.9	16.1	9.2	6.4	3.6	

Rather than the "teeth-to-tail" ratio, what is important is the absolute cost-effectiveness of the logistic system in providing adequate support for the combat troops without regard to how this relates to the ratio of combat to support troops. The question thus becomes, "How can R&D help the Army improve the effectiveness and efficiency of its logistic system"?

In addressing this question, it is appropriate for proper emphasis to determine which of the logistic support functions is the most manpower intensive. With respect to this matter, the Group was informed by representatives of the ALOGC that maintenance requirements have by far the greatest impact on overall logistics support to be furnished. It was said by General Graham at ALOGC that maintenance tends to drive a great deal of the whole pattern of logistics. He observed, for example, that considering the classes of supply, the major problem area, repair parts, is driven by maintenance requirements. Second in importance is the supply function, with transportation, services and facilities following along in that order. The Group did not explore the facilities function, feeling that it is largely a contract support activity not too closely related to field Army logistics support, and generally not very amenable to R&D influence.

**Rates Expressed as cases per 1,000 average Army strength per year.

In the sections to follow, on-going developments relating to maintenance, supply, transportation and service functions of the logistic system will be reviewed, some conclusions will be drawn concerning them, and finally some recommendations will be offered based on these conclusions with respect to how R&D can contribute to those matters that appear to offer the highest pay-off in achieving a logistic system that will support adequately the Army's combat forces at minimum cost.

IV. Maintenance

Even though the Terms of Reference for the ad hoc Group on Logistics R&D stated that maintainability was not to be one of the prime factors considered, the Group recognized that since maintenance is the largest contributor to the logistics burden, some part of the study must be addressed to this subject.

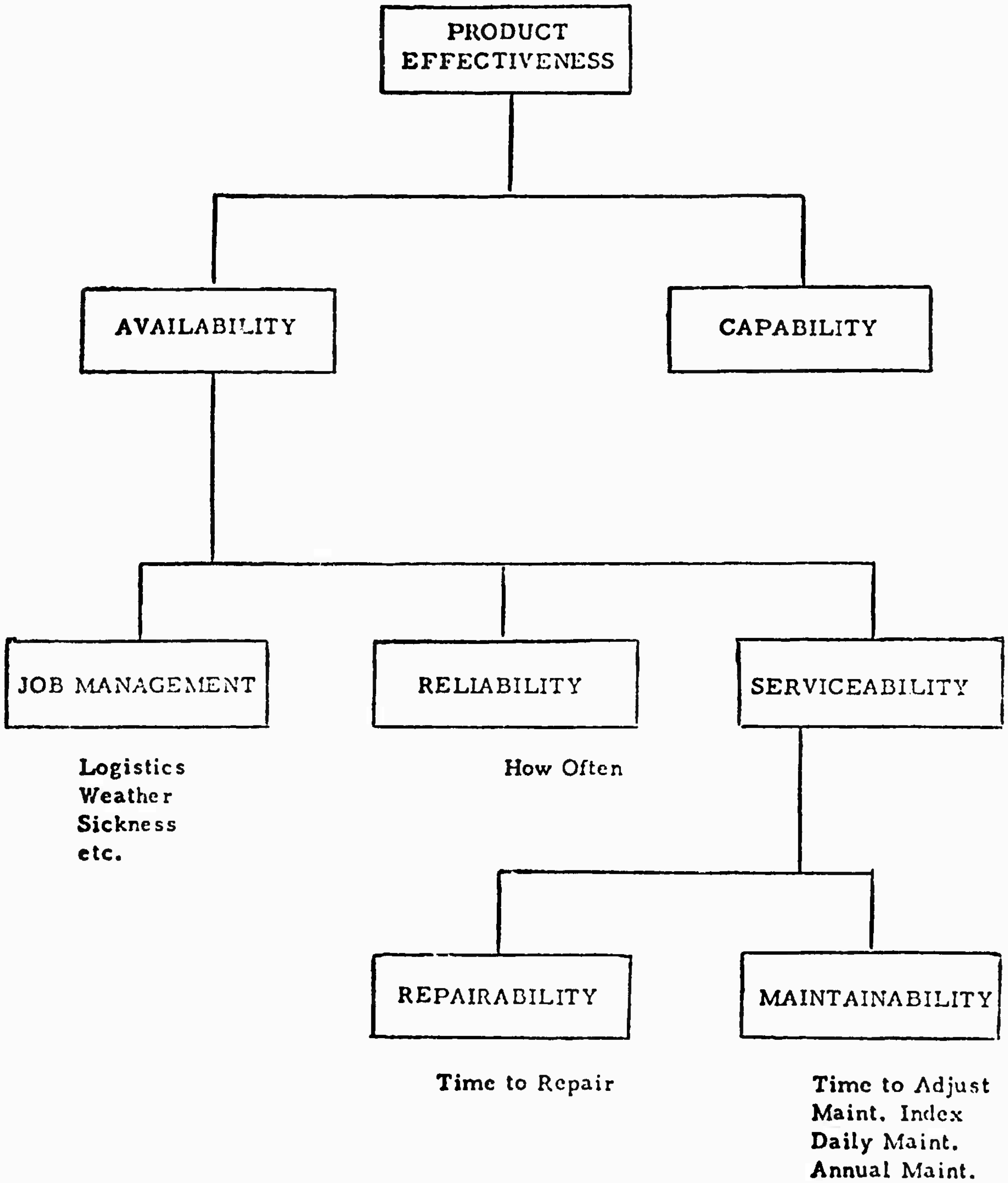
It was found that a substantial amount of time and effort in the new equipment acquisition process is devoted to the question of maintainability, but primarily as an after-the-fact consideration. Once a piece of equipment has been designed, or at least firmed up in the engineering development phase, a substantial amount of time is devoted to developing maintenance practices, to establishing the provisioning for spare parts, to determining the organization levels where various types of maintenance will be performed, and to developing special kits and tools with which to perform maintenance. Furthermore, once the equipment is in the field, a substantial amount of training goes into the area of maintenance.

Where adequate data are available, as they may well be from either commercial or military experience, trade-offs among reliability, repairability, maintainability and capability to achieve maximum overall

product effectiveness can and should be made in the original development plan. All of this effort is essential to the successful operation of complex equipment, but it was not obvious to the Group that a proper balance is being achieved among the various factors involved. For example, referring to Figure 1, a product effectiveness model used by the Caterpillar Corporation, it can be seen that the overall effectiveness of a product may be determined by the relationship among several factors that include capability, availability, job management (logistics support), reliability, serviceability, repairability and maintainability. Even though it is recognized that each of these factors usually receive a substantial amount of attention in the specification for new equipment, little evidence could be found of the existence of an adequate model that can determine the proper balance among these factors so that a system will achieve maximum overall effectiveness. Product effectiveness can, of course, be measured in terms of dollars (direct operating cost, or life cycle cost) or in terms of mission effectiveness (kill ratio or success on the battle field). It is not so easy to determine a specification requirement for maintainability. Such specifications today are established primarily as a matter of judgment in terms of frequency of failure, time to adjust, time to repair or some other relatively easily measured parameters.

It has been noted in past Army surveys that while many contractors may have difficulty in demonstrating parameters of capability and reliability, they seldom miss their demonstration of required maintainability. It was also noted that maintainability actually experienced in field operations is often ten times poorer than that demonstrated during the contractors R&D

demonstration. It is obvious, therefore, that even though maintainability is an age old subject that should be well understood, it actually is lagging behind reliability in terms of technical understanding and attention.



CATERPILLAR CORPORATION
PRODUCT EFFECTIVENESS MODEL

Figure 1

Many Army organizations have developed analytical techniques to evaluate each of the factors shown on Figure 1, but the Group is not aware of any effort to develop an analytical technique or model that will allow adequate trade-offs among these various factors. For example, it is not clear that we know how to trade off between reliability and repairability in order to achieve the maximum product effectiveness; nor are we aware of a model that will determine the optimum trade-off between maintainability and capability since trades in this area will often affect not only the weight and cost of a product, but also spare parts provisioning and other logistics support that goes to back up a piece of equipment in the operational inventory. A typical question to be answered might be: "Which would be more desirable from a product effectiveness standpoint -- to specify that future Army trucks must have a 1,500 hour service life in order to substantially cut down on logistics support for vehicles, or to specify that logistics support considerations would not be permitted to increase weight or initial cost of the vehicle?"

This whole question of an overall product effectiveness model needs more attention from the Army, not only to create a useful model, but to develop reliable input data on maintenance manhours and costs that we have been informed do not exist. Without such data, the question of design to life cycle cost may be moot.

The Group firmly supports the design-to-cost concept as expressed in Army Secretary Calloway's memorandum of 3 July 1974 to the Chief of Staff, but in order to arrive at an overall high confidence measure of product effectiveness, with the factors shown in Figure 1 properly evaluated and balanced, we believe that life cycle costs must be used as is brought

out in Secretary Calloway's memorandum. Otherwise, we would be misled about the real cost to the Army. The fact is that the state-of-the art for estimating life cycle costs is still primitive. To help improve the state-of-the-art of life cycle costing, it is recommended that a task force be formed to work in depth on specific weapons system programs to help establish the basic principles of life cycle costing and realistically to exercise these principles so as to obtain a better understanding of how well it can be done. It may be well for such a task group to use as examples a program that has been completed; i.e., retrospectively, and a new program being considered.

It is our understanding that the Army Logistics Management Center has the capability to undertake this assignment. That organization should be encouraged to pursue such an effort on an urgent basis with a strong input from the industrial sector.

The presentation at our meeting on 9 May 1974 at AMC headquarters by members of the AMC included discussions of maintenance depots and the effort to reduce their numbers and to improve efficiency. Several factors seemed to indicate very poor productivity. In the presentation by Colonel Wren it was reported that for depot workload planning a figure of 1730 to 1760 hours per man per year is used. This compares reasonably well with approximately 1800 hours per man per year on-the-job availability in industry. For organizational maintenance performed by motor pool mechanics in infantry and artillery battalions, however, the figure is only 1061. There would seem to be ample room for improvement here and the problem deserves management attention.

The Group believes that field maintenance will always suffer from

two related, fundamental factors. The first is the relatively short "hitch" of the individual soldier, and the second is the extremely short training period (fourteen weeks) in which to develop the skills required for the maintenance of complex equipment.

A comparison between the Army training period of approximately 14 weeks to develop mechanical skills for the average soldier with a comparable training period in industry seems appropriate. Current industrial training programs for mechanics doing minimum maintenance and repair on civilian equipment range from 44 to 60 weeks, depending on the educational qualifications of the trainee. A high school graduate from the upper 10% of his class is generally trained to basic qualifications in 44 weeks. A high school graduate below the upper 10% of his class, but not below the 25% point, may take as much as 60 weeks. The much shorter period of training for military personnel doing field maintenance and repair must obviously increase the burden on the supply system that would result from poor maintenance. Inadequate training contributes to incorrect diagnoses that lead to ordering the wrong repair parts. This aggravates the supply problem to be discussed in the following section.

V. Supply

After maintenance, the second most manpower intensive logistics function is supply. The Group heard from Mr. Charles A. Hassis of ODCSLOG that while a fundamental problem in supply is simply the great number of line items in the supply system, the greatest problem is people. He cited from a recent analysis of supply in the European Theatre that the lack of skilled and experienced supply clerks, coupled with the lack of skilled maintenance personnel, was the primary reason that some 35% of

whatever was ordered was turned back to the supply system. The Army is engaged in extensive efforts to cut the number of items in the catalog; it appears that a greater contribution to the overall reduction of logistics support could be achieved by an increased effort to reduce that 35% to near zero.

Mr. Hassis cited several other supply problems that contribute to support requirements. For example, there are in inventory simply too many makes and models of the same equipment. At least some of this is the direct result of congressional preoccupation with the idea that there is something inherently wrong with any sole source procurement, no matter how sensible that procurement may be. While sole source procurements are possible and often justified, an outstanding example of the congressional attitude was the pressure put on the Army to support a new competitive procurement for the follow-on buy of light observation helicopters that resulted in adding both maintenance and supply support requirements for a helicopter of lesser operational effectiveness than the one already in the inventory.

Another problem discussed by Mr. Hassis related to the sophistication and/or complexity of equipment. This has a direct effect on the number of line items added to the inventory and on the skill levels demanded of personnel handling supply matters related to such equipment. Compounding this difficulty is that of escalating costs due to inflation. Once committed to a highly complex item of equipment, it generally follows that the only satisfactory way to procure spares for that equipment must be on a sole source basis from the original vendor. In an inflationary environment, it is very difficult to keep these negotiated procurement costs within reasonable limits.

Two, final, somewhat interrelated problems mentioned by Mr. Hassis are those resulting from the wide geographical dispersion of our forces and the attendant demands placed on long lines of communication. The dispersion of itself has a direct impact on support requirements, but the compounding difficulty is that introduced by garbled communications associated with the extreme distances involved. In a highly automated supply system, bad communications can cause all sorts of mistakes that have resultant impact on support requirements.

Needless to say, the Army is not ignoring the supply problems discussed by Mr. Hassis. The Group was impressed with the scope and quality of the educational program available at the Army Logistics Management Center. Although the area of training responsibility of this Center is aimed primarily at the wholesale and acquisition management level, it is seeking to tackle the people problem headon.

The problem of sophistication and/or complexity of equipment is being addressed through greater emphasis on early trade-off studies related to formulation of the ROC document in the revised system acquisition procedures. Those studies, plus the increased emphasis on life cycle costs, should result either in reduced sophistication and/or complexity or at least a clearer and stronger justification of whatever sophistication and/or complexity may finally be accepted.

While there is little that the Army can do about the problem resulting from the geographical dispersion of its forces, it should be possible with intelligent application of existing communication technology to reduce significantly the problem of lack of clarity in communications. The Group did not explore this problem beyond recognizing that it exists. With the

great volume of data transmission that is now routine in commercial practices, software programs are available to apply to transmission controls that can virtually eliminate errors in digital transmissions. Error rates as low as one in 10^{6} bits are said to be routine. Thus, it should not be necessary to turn to R&D to solve the problem of errors in transmission.

The same must be said of the basic people problem involved in the supply function earlier identified in the discussion on maintenance. This is not a matter for R&D, but for education and training. It is now being addressed as we have indicated.

Where R&D can contribute most effectively to the reduction of support requirements related to supply is in the design either of new equipment or of improved components for existing equipment. The Group was impressed with the scope of effort described for us by Mr. McCutchen of MERDC and Mr. Looft of the NVL at Ft. Belvoir. Similar development efforts are underway at TACOM. It is quite clear that the Army is already pursuing several design concepts that will undoubtedly contribute to a significant reduction in logistics support. Some of the concepts being pursued are: families of equipment, equipment assembled from building blocks or modules, and equipment designed to be multifunctional.

A. Families of Equipment

A "family" was described as a collection of different sizes of equipment that perform essentially identical functions at varying levels of work output. For example, a family of units to provide total environmental control (heating and air conditioning) is being designed in 9,000, 18,000 and 30,000 BTU/H

versions. These units each contain the same basic control system that, with minor changes, accommodates many variations in source electric power. Functionally, these three units will replace some 46 air conditioners, dehumidifiers, heaters or humidifiers that are now in the inventory.

A similar "family" of diesel generators is under development where the design goal is to maximize commonality and interchangeability of component parts or subsystems. This technique can obviously be extended to other equipment as available development and procurement funds permit. The extent to which this approach can be pursued is not so much a technical problem as it is a policy matter, as was illustrated by the fact that in the generator "family," the Army was required, over their objections, to make three "families"; i.e., go to three vendors, so that the total effort could be distributed and small business could be competitive. It is quite clear that some of the advantages of this approach were negated by political pressures.

B. Building Blocks or Modularity

This approach to reduction of items in the inventory is well understood and extensively practiced. The examples used in the presentation to the group were: camouflage nets that can be built up to a variety of sizes and shapes from two basic units; shipping containers that can be handled as a single, standard 8' by 8' by 20' unit yet can be broken down into smaller units; and standardization on one module in night

vision devices that can be applied to meet several user requirements. These examples are but a few of the ways modularity can pay off in the supply system. Modules can be circuit boards that serve in several items of communications or other electronic equipment, bridging elements that can be built into several classes of bridges, building modules that can be assembled in various sizes for different purposes, vehicles for which parts commonality can be specified, or any one of a large variety of equipments. It is quite clear to the Group that the advantages of commonality or modularity are well understood and being practiced by the Army.

The counterbalancing disadvantages of modularity such as added time and cost of development are also appreciated. It is true that the amount of reduction in supply support requirements that can be achieved by this approach will vary from system to system so that judgment must be applied in the decision to use or not to use this approach. Although the Group did not have the time or opportunity to make an exhaustive design analysis of materiel now in development, we have no reason to believe that those responsible for the design function both in government and industry are not adequately informed on the advantages and disadvantages of using this approach to minimize supply requirements.

C. Multifunctional Units

A third approach to the reduction of supply support is to design new systems so that they can serve more than one

function. The examples presented to the Group are: bridging for the 80's that will seek to meet assault bridging, wet support crossings and dry support crossings with what will be essentially one system using a common main support girder with additional transporting, launching, and supporting items to adapt to individual cases; the family of military engineer construction equipment (FAMECE) that will provide seven different work modules all using a common power module; and a completely new water treatment process based on reverse osmosis that will replace four different processes and many different sizes of equipment now in use. The goals to be achieved by this approach offer promise of dramatic reduction in supply support, but its practical application in some instances raises questions that need to be explored thoroughly by the user before final production commitments are made. For example, in FAMECE, how many power modules are to be produced per group of seven work modules? This is an inventory question, not a technical problem. The same sort of question can be posed in regard to bridging for the 80's.

In summary, the Group is of the opinion that R&D can make significant contributions to a reduction of supply support requirements through good design practice applied to materiel developments, that the Army development agencies are aware of the advantages to be had in this field, and that the several design approaches available are being pursued. We believe, however, that continuing attention to supply requirements must be

paid in the requirements dialogue between the user and the developer to be sure that adequate advantage is taken of the available design approaches in each new development.

VI. Transportation

For purposes of this discussion, the Transportation System is assumed to include the equipment for various modes of transportation; that is, ground, air and water, as well as the containerization of components and the rather comprehensive and elaborate system for keeping track of containers and parts therein during the transportation process.

In the past there has been very little visibility and control of the vast quantities of materiel flowing through the pipeline, and this in turn led to huge inventories, much of which did not get to where it was needed. We found that significant advances have been made toward improving the accountability of logistics items throughout the transportation and storage process. This should lead to more efficient use of resources by keeping the amount of required inventory to a minimum and by having the right parts at the right place at the right time. Although it is probably too early fully to judge the effectiveness of the system, it appears that it is capable of doing a good job.

The design of the data processing systems that were described to us seems appropriate. However, if there has not been at least a preliminary exchange of information and techniques with Ballistic Missile Defense personnel responsible for data processing, it is recommended that this be done. An exchange of information on problem areas may stimulate some thoughts that would be beneficial to any future improvements in the data processing systems for logistics transportation systems.

The use of containers and the routing and location of them as a function of time using cards that are fed into the data processing system represents a potentially significant improvement in the overall supply system. In order further to automate the system, however, it would appear that R&D resulting in the development of peripheral equipment that will properly code information onto containers and then automatically scan it at appropriate check points could reduce manpower requirements and also eliminate some of the human errors in the transportation system. Also, new technology in automated warehousing can probably be used to reduce manpower at terminals and depots. The changes that have occurred in civilian transportation systems to improve efficiency and to reduce labor by the substitution of capital equipment should be taken advantage of as much as possible by the Army. Since the total transportation system also involves the A.F. and Navy, close coordination and standardization with the A.F. and Navy is, of course, necessary.

From the briefings we received, one would gain the impression that, whereas the Army is doing a good job of using a systems approach at the level at which this approach is being used -- such as in the data processing systems -- there may be a lack of a sufficiently broad systems approach to the total logistics system and perhaps more specifically, insofar as this section is concerned, to the transportation system. The question - whether or not a sufficiently broad systems approach is being taken - should at least be asked. In doing so, various scenarios should be used.

Also, the question should be asked as to whether the overall system is too oriented to peacetime operations and not sufficiently

oriented to various wartime contingencies. The point was made to us that although we have always had the luxury of time to build up and transport huge inventories in previous wars, we shall probably not have this luxury in another war. We shall have to distribute what we have quickly and precisely. This will require the efficient use of all three major modes of transportation. It is recommended that overall system operational studies of how the system might work under various war scenarios should be carried out, that the overall logistics system be exercised as much as possible through exercises such as REFORGER, and that as a matter of policy at least parts of the logistics system should be used more extensively than in the past to respond to national and international natural disasters such as earthquakes, floods, hurricanes, etc. Certainly elements of the transportation system such as helicopters, ships and A/C can be used to deliver food, shelter, bridging, etc., to victims of disaster. Such a policy would not only help diplomatically but it would also exercise the logistics system and so help to maintain its state of readiness to perform the Army's prime mission.

The Group was informed at one point that T.O.E.'s for transportation have not been updated since World War II. This matter should be investigated. Certainly new concepts have come into being that would merit such an examination.

Although there may not be major improvements in the long-range transportation of supply items by sea and air, one might expect major changes in the transportation system in the theater of operations. For instance, a suggestion was made that all repair parts be delivered by air. This appears to make very good sense for reducing downtime, making sure

parts get to the right place, and for reducing inventories. At another point in our briefings, however, we were informed that there has been very little effort given to quantifying requirements for helicopters serving a logistics role in the Army. Perhaps no new basic aircraft are required for this delivery of repair parts, however, some major or minor modifications to perform a logistics role may well be in order. This matter should at least be examined.

We were informed that the watercraft fleet is obsolete and proliferated. Hovercraft may provide an answer to a number of logistics requirements, particularly in scenarios where the Army has to unload large quantities of equipment and no ports are available. An excerpt from the "Executive Summary - U. S. Army Trans-Hydro Craft Study" states the situation and the hope for doing something about it.

> "For various procurement, political and contingency reasons, procurement of different types of U. S. Army marine craft has proliferated to a point where standardization is no longer feasible with the existing fleet. Currently there are 9 types of logistics 'over-the-shore' craft and 71 types of coastal, harbor and inland waterway craft in the Army inventory. The development of a new U. S. Army trans-hydro craft fleet consisting of 6 types of logistics 'over-the-shore' craft, and 8 types of coastal, harbor and inland waterway craft, provides an opportunity for DA planners and U. S. AMC procurement personnel to simplify and standardize major components and communications, navigation and electronics equipment. This

will also result in long-range savings in personnel and in numbers of units, reduction in prescribed load lists and authorized stockage lists, and in overall reduction in theater stockage of marine-oriented items."

It is our understanding that over 70% of the transportation of supplies is required for fuel. Although improvements have been made in forward area refueling, an overall systems approach should be taken to seek improvements in meeting the overall fuel requirement and to determine whether or not present methods offer the best solution. Among the actions that can be taken to help reduce this large transportation load both for the short range and the long range are the following:

1. R&D on combustion can be intensified. TACOM has made progress in this area. Recently they and the NSF have increased activity on more basic combustion research aimed at improving fuel economy. This can reduce the fuel load on transportation.

2. Efforts to develop engines that can operate on a wider range of fuels should be vigorously pursued. TACOM has in the past developed multifuel engines and is aiming toward engines in the future that will operate over a much wider range of fuels.

3. From a longer range point of view, the concept of fuel depots, where fuels can be generated by synthetic means from readily available resources in the local area should be investigated. This could drastically reduce the large fuel transportation burden that now exists and make the Army more self-sufficient.

VII. Services

The fourth major logistics support function is that of the various

services that must be furnished if the American soldier is to continue to enjoy the standard of living to which he is routinely accustomed. This function includes services such as the APO, laundry, post exchange, and recreational activities. The Group addressed little or no attention to this function for two reasons: first, we were informed that it represents a very small percentage of the overall logistics support of the Army; and second, we saw no obvious way that R&D could be applied here to make any significant contribution to the reduction of logistics support requirements.

There is, however, another element of service support that contributes heavily to logistics support requirements. This element was also not considered in our study. It is the medical service that is so important to the soldier's well-being. The Group had no particular expertise to look at this element of service support, and since it is a separable element under a service chief; i.e., the Surgeon General, it is our opinion that any review of requirements in this field would more appropriately be handled by medically experienced advisors.

VIII. Conclusions and Recommendations

A. Conclusion: The "teeth-to-tail" ratio is not a valid measure of a logistic system's adequacy or inadequacy. (Pages 1, 5, 6)

Recommendation: That the Army take deliberate action to discourage the use of the "teeth-to-tail" ratio as a measure of the adequacy or inadequacy of the logistics system.

B. Conclusion: Although the Terms of Reference did not direct the Group to address the subject of maintenance, it is clear that maintenance requirements produce the greatest impact on the

*Page numbers refer to text that supports the corresponding conclusions.

support effort. In fact, although the Group recognizes the importance of the design-to-cost concept, it is our judgment that an adequate evaluation of the cost effectiveness of maintenance is necessary to life cycle cost definition. (Pages 6-11)

Recommendations:

1. That a task force be established with the objective of improving the procedures for and understanding of life cycle cost with particular emphasis on maintenance costs.

2. That the Army insure that the required cost and operational effectiveness analysis (COEA) and trade-off determination (TOD) are positively reviewed for evidence that the life cycle cost including maintenance and logistics support costs were considered in the design alternatives.

C. Conclusion: Adequate maintenance and support cost data are not available by weapon system on fielded equipment. This type of data is essential if the Army is credibly to take action to improve items of equipment with the objective of reducing support costs. The data are also essential for use in the development cycle for new equipment if duplication of past mistakes is to be avoided. (Pages 7-11)

Recommendations:

1. That the Army give high priority to the development of a maintenance/cost data reporting system by individual item of equipment.

2. That expansion of the Army's Sample Data Collection System be considered as a method of meeting this requirement.

D. <u>Conclusion</u>: Supply system improvements; e.g., reduction in line items, reduction in echelons, and increased use of air transport will make the second most significant contribution to reduction of support costs. R&D can make a contribution to a reduction in line items through adequate attention to modularity/commonality in the development process. The degree to which this is true will vary from system to system. (Pages 12-18, 21)

<u>Recommendations</u>:

1. That a study be made of energy usage and system cost effectiveness of transporting supply items by air.

2. That procedures be strengthened to assure that adequate and continuous logistic support considerations are included in ROC development and in early design phases of new developments.

3. That each commodity command set objectives for achieving modularity/commonality for its commodities. It is recognized that various classes of equipment within a commodity command may require a different approach and objective.

E. <u>Conclusion:</u> It is apparent that the linkage between the lead lab developers of modular/standard components and the systems development program managers is relatively loose. In particular, the program manager may be expected to have strong incentives to meet performance, schedule, and/or procurement cost goals that may conflict <u>at his level</u> with the use of "standard" modules. (Pages 15-18)

<u>Recommendation</u>: That in program manager training, the importance of and approach to the use of "standard" components be addressed

in much greater detail. In practice, all program managers should be tasked to identify and use standard components with commensurate authority and capability to trade off their use against user preferences, original equipment cost, overall life cycle cost, etc. His skill and success at this task should be clearly identified as a major evaluation metric of his overall performance.

F. Conclusion: The Group concluded that the Army's current maintenance training and organization does not favor the development of highly trained specialists or of the efficiencies that would derive from increased availability factors for those specialists. In particular, the "wrench time" available per man in an organizational maintenance unit is roughtly half that of a comparable civil maintenance specialist and the initial training period is approximately 1/4 that of industry standards. (Pages 11-12)

Recommendations:

1. That every effort be made to expand the amount of formal training given support specialists to a level more comparable with industrial practice.

2. That means be found to relieve qualified specialists of the less skilled and routine concerns of military activity. Additionally, productivity standards for individuals should be established and their performance compared to parallel functions in industry. One way in which R&D can support this effort is by the continued development of improved training techniques.

3. That time studies be made of maintenance and repair operations and that standards be established for both depot and field operations.

G. Conclusion: There should be timely recognition of technical obsolesence of purchased industrial production items or of unique military equipment using commerical components. (Pages 13,15,22)

Recommendation: That minimum cost criteria be established for retirement of technically obsolescent materiel or materiel that employs technology that is commerically obsolete.

H. Conclusion: Although significant improvements have been made in the transportation system, particularly in keeping track of materiel throughout the pipe line, we believe additional improvements can be made in the transportation system through R&D (either Army sponsored or adapted from civilian technology) directed toward increasing the automation of routing and handling of supplies. (Pages 19-20)

Recommendation: That a development program be undertaken to further automate the transportation system.

I. Conclusion: The Army's watercraft fleet is obsolete and proliferated. (Page 22-23)

Recommendation: That implementation of the recommendations of the "U.S. Army Trans-Hydro Craft Study" be given high priority.

J. Conclusion: A large part of transportation (70%) is associated with fuel transport. Among the ways in which R&D can contribute in the short and long term to decreasing the fuel load on the transportation system are the following:

1. Conduct basic research to improve combustion to reduce fuel consumption.

2. Develop engines to operate on a wide variation of fuels.

3. Examine how fuel depots to generate synthetic fuels can be developed to reduce fuel transportation costs and increase Army self-sufficiency. (Page 23)

Recommendation: That steps be taken to insure that efforts in 1. and 2. above are properly supported and that the longer range concept of energy depots be investigated.

K. Conclusion: While we believe maximum advantage should be taken of civilian developments in automation and manpower reduction in the civilian transportation system, we also believe that the Army's transportation system should be checked and exercised as much as possible against various wartime scenarios. Also, we believe the Army should, as a matter of policy, have a stronger mission in helping in times of national and international natural disaster. Such action would help test-out and maintain logistic readiness. (Pages 20-21)

Recommendations:

1. That the Army continue and expand system operational studies of the transportation system performance in various war scenarios.

2. That as much exercise of the transportation system as possible be performed through major exercises such as REFORGER and that such exercises be made as realistic as possible from a logistics point of view.

3. That the Army exert its influence in establishing a national policy to use its transportation system and indeed as much of the logistic systems as possible) to help in natural disasters such as floods, earthquakes, and hurricanes. Whether or not some of the cost of the logistics system can be charged against such a mission should be investigated.

L. Conclusion: The greatest degree of standardization among all branches of the military and the civilian transportation services must be achieved and maintained. (Page 20)

Recommendation: It is recommended that this matter be given high priority.

Appendix A

Terms of Reference
ASAP AD HOC GROUP ON LOGISTICS R&D

1. Background

a. Compared to the other armies of the world the US has a very large number of support personnel compared to combat or "operational" personnel. To a large degree this is due to a tremendous logistics burden imposed by our scattered forces employing sophisticated equipment and demanding a high level of personal support.

b. In the past we were willing to pay the price in terms of men, materials, and money. However, with the constraining budget, and projected reductions in military manpower, it becomes imperative to try to achieve a more favorable ratio of support to operational personnel.

c. To this end, R&D must play a key role in helping to provide a more favorable support to operational ratio and reduce support costs. R&D can contribute in three major ways:

(1) By designing more reliable, operable, and easy to maintain equipment.

(2) By concentrating on commonality and modular design of equipment

(3) By assisting in the development of more efficient transportation, distribution, communication and maintenance equipment which will improve the overall logistics system.

2. Terms of Reference.

The Army is currently trying to emphasize the operability, reliability and maintainability requirements, and it is suggested that this area not be addressed directly, thus, the working group should concentrate on the remaining factors, specifically:

a. How can the Army move to a modular approach (commonality on at least sub-system or component level) for combat vehicles, weapons (automatic cannon, tank guns, etc.), helicopters and other classes of equipment. The Army has presently taken this step in the area of thermal night sights -- with anticipated pay-off in not only logistics but unit cost as well. It is proposed that:

(1) the desirability of such an approach for key equipment classes be investigated,

(2) factors impeding the implementation of modularity be identified (for example, each PM chooses his own sub-system), and

(3) the manner that trade-off decisions are made be investigated.

This latter point should consider how soon and who needs to make decisions on cost, schedule, and performance so that the resulting logistic burden for that class of equipment is minimized.

b. Consider the question, "What can R&D accomplish in the areas of transportation, distribution and communications systems with appropriate hardware and software development, keeping in mind the fact that major influences may be exerted by organizational, tactical or managerial steps?" It should be realized that the Army in its logistics support operations has been relying heavily on off-the-shelf commercial equipment purchased primarily with PEMA funds and sometimes have not had a strong enough coupling to R&D.

c. An assessment should be made of the implications of both the current deployment scenario and predominately CONUS based Army that would have to be rapidly deployed to nonprepositioned bases on the required equipments.

(4 January 1974)

APPENDIX B

The ASAP ad hoc Group on Logistics R&D was composed of the following members:

LTG Austin W. Betts (USA-Ret)
Vice President for Planning
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Mr. Jack I. Hope
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Chrysler Corporation

Dr. Robert M. Lockerd
Manager
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Office of Director of Developments, OCRDA
(Point of Contact with Army Staff)

LTC Larry A. Baker
Management & Test Division, OCRDA
Special Member but succeeding
Major Fred Murrill as Military Staff Assistant upon
Major Murrill's reassignment

Major Fred Murrill
Office of DCS/LOG
Military Staff Assistant (thru May meetings)

LTC Freddie Kemp
Office of DCS/LOG - replacement of DCS/LOG Representative Major Fred Murrill

Dr. Ralph E. Fadum (Chairman)
Dean, School of Engineering, N. C. State University

APPENDIX C

Briefings, Agencies, and Subjects Reviewed

20-21 February 1974	Orientation, Pentagon
Materiel Development and Acquisition Cycle	LTC Stanton, OCRDA MAJ Stieglitz, OCRDA
Logistics System Overview	
Supply	Mr. C. Hassis, ODCSLOG
Direct Support System (DSS)	MAJ D. Sexton, ODCSLOG
Maintenance	LTC H. Gracey, ODCSLOG
Transportation	LTC P. Scott, ODCSLOG
Logistics Information Systems	MAJ L. Saloman, ODCSLOG
Logistics Systems Problem Areas	MG D'Ambrosio, Dir Supply & Maint, ODCSLOG

9 May 1974	Marine Corps/HQ AMC
Marine Corps Logistics/R&D Activities (0-10 yr time frame)	LTC Harp, USMC
AMC Logistics Support Mission Structure, and Objectives/ Improvements Underway	MG Smith, DCG for Log Spt, HQ AMC
On going AMC Projects to Improve Efficiency of the Log Spt Structure	COL V ren, Army Maintenance Management Center, AMC

10 May 1974	Ft Belvoir (MERDC/Night Vis Labs)
MERDC Mission Activities	COL Hukkala, CO MERDC BG Sterling, DC TROSCOM, AMC
Modular Trends in Equip Design Families Building Blocks Multifunctional Units	Mr. McCutchen, MERDC
Improved Trans, Dist, and Maintenance Equipment	Mr. McCutchen, MERDC
Night Vision Laboratory Module Standardization	Mr. Looft, NVL

6-9 August 1974	Fort Lee (ALMC/Log Ctr)
ALMC Mission/Organization	COL Wilkinson, Cmdt ALMC
Research Development and Engineering Courses	Mr. Folares, ALMC
Maintenance Mgmt Course	LTC Peterson, ALMC
Systems and Cost Analysis Courses	Mr. Howard, ALMC
Institute of Log Research	COL Tambe, ILR
Life Cycle Cost Procurement/ Design to Cost	Mr. R. Williams, ILR
U. S. Army Log Ctr Mission, Organization, Major Program Objectives	Mr. Hurford, Log Ctr
Logistics Materiel Developments	Mr. Alley, Log Ctr COL Morris, Log Ctr
Commercial Equip, Container Systems, TransHydroCraft Study	COL Casey, Log Ctr
Determining Log Manpower Reqmts	LTC Pierce, Log Ctr
Discussion of Potential Leverage Areas for Log/R&D	MG Graham, CO Log Ctr
Logistics Lessons Learned Yam Kippur	Mr. Fogel, Log Ctr
Baseline for Logistics Training	MAJ Bradshaw, Log Ctr
Log Systems Design Projects	LTC Norton, Log Ctr

5-6 September 1974	Work Session, Pentagon
This meeting was devoted to the final assembly of a draft report. The only agenda items were the following:	
Informal discussions on Logistics/R&D problem areas.	MG Cooksey, DCRDA MG An[illegible]elli, ADCSLOG
Mission of Logistics Evaluation Agency (LEA).	Colonel [illegible]held[illegible]n, ODCSLOG